

Top 3 Prototyping Challenges in Robotics

Brian H. Powell

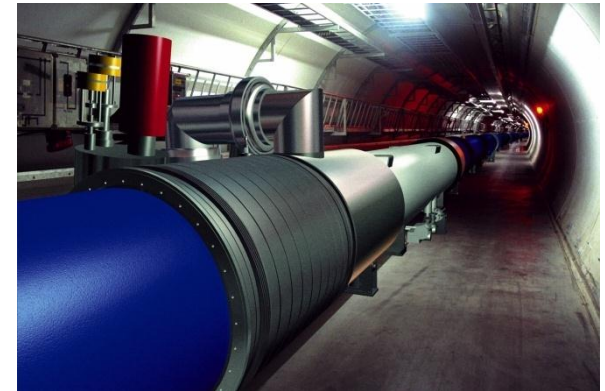
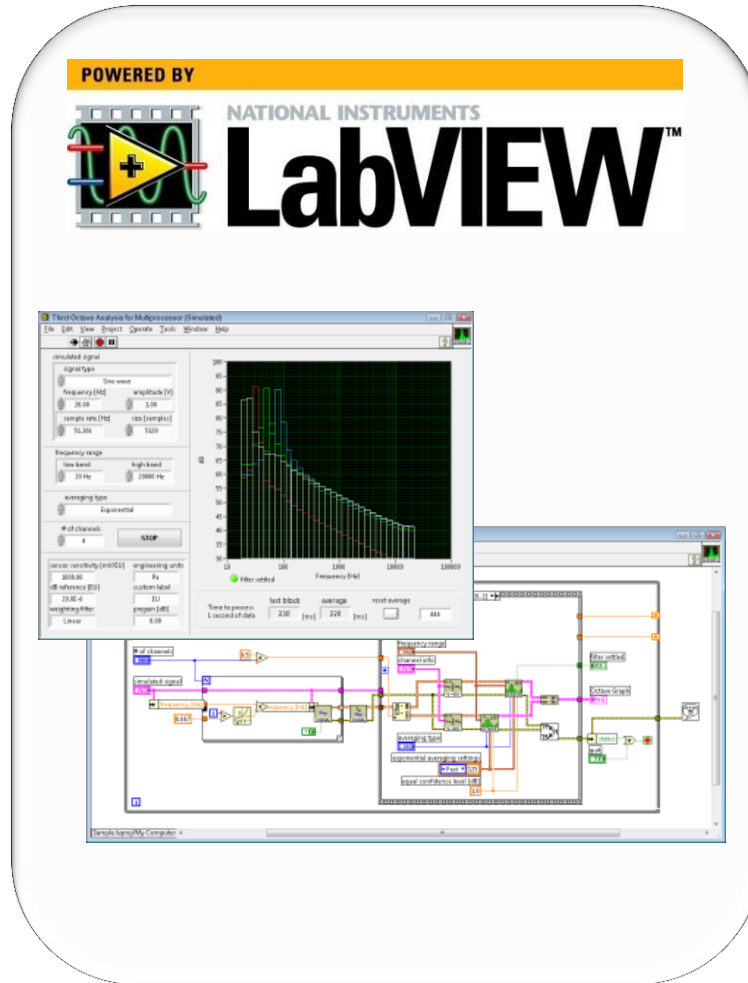
Principal Software Architect

LabVIEW Robotics

K to Rocket Science



LEGO Education
WeDo

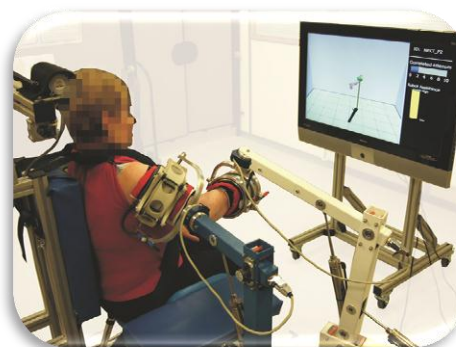


CERN Large Hadron Collider

Robotics Technology is an Emerging Priority



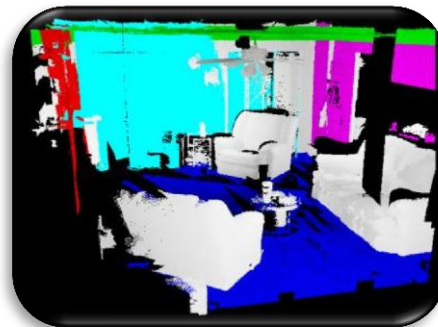
National needs



Elderly and disabled



STEM Education



Improvements in core technologies

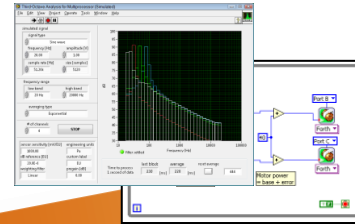
Robotics Continuum



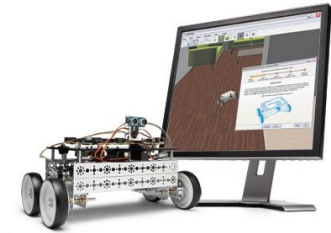
LEGO® WeDo®
powered by LabVIEW



LEGO® MINDSTORMS® NXT
powered by LabVIEW



LabVIEW for LEGO
MINDSTORMS



LabVIEW Robotics

Kindergarten – 8

Grades 9-12

University

Industry



FIRST Adoption of NI Technology



FIRST LEGO League



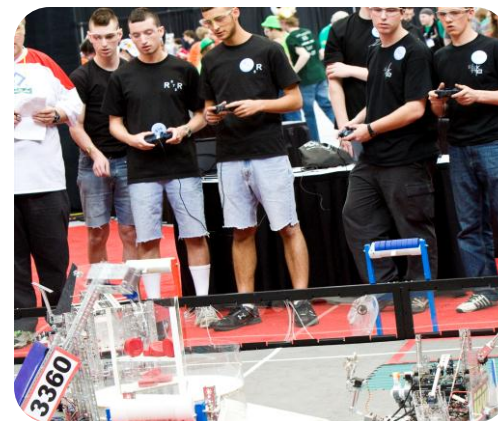
147,000 students

FIRST Tech Challenge



11,000 students

FIRST Robotics



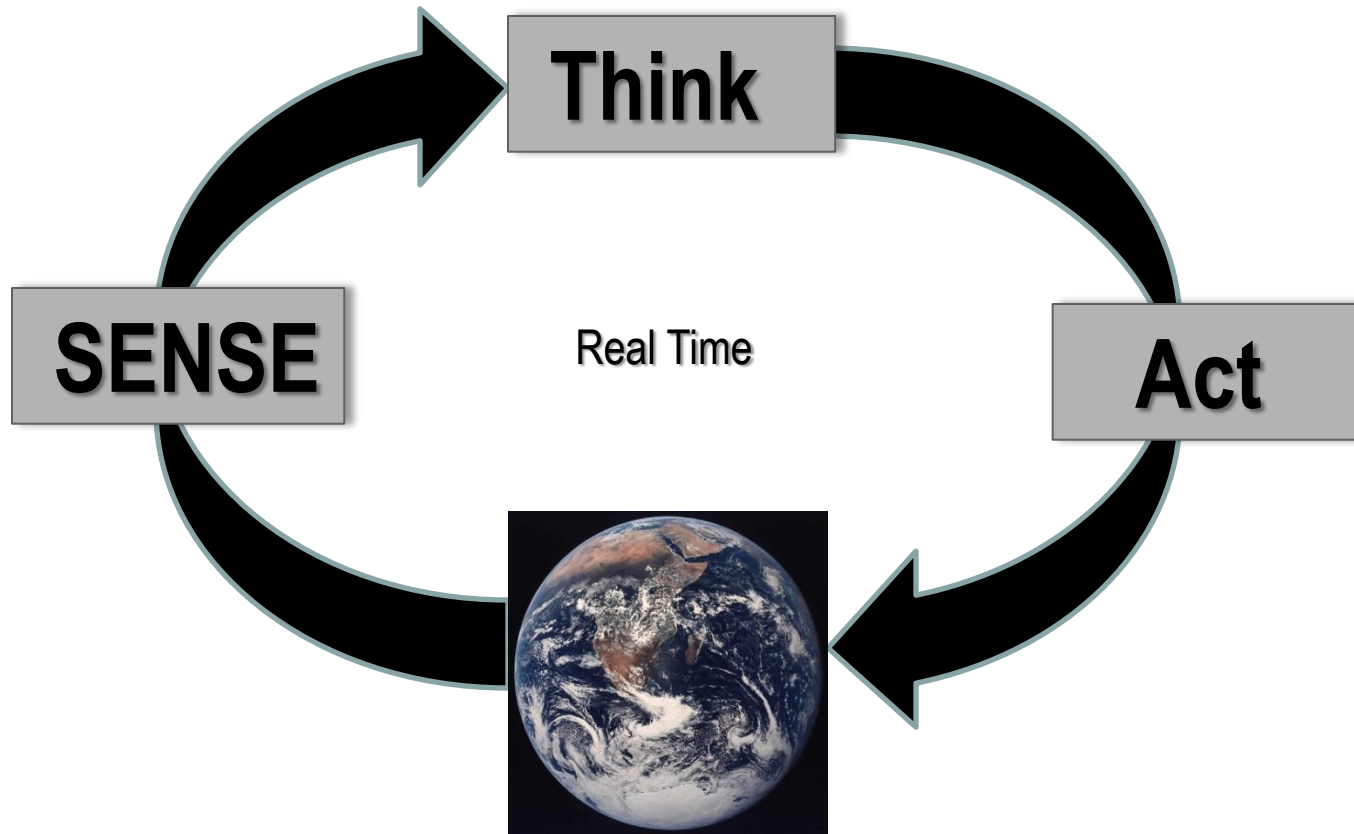
45,000 students

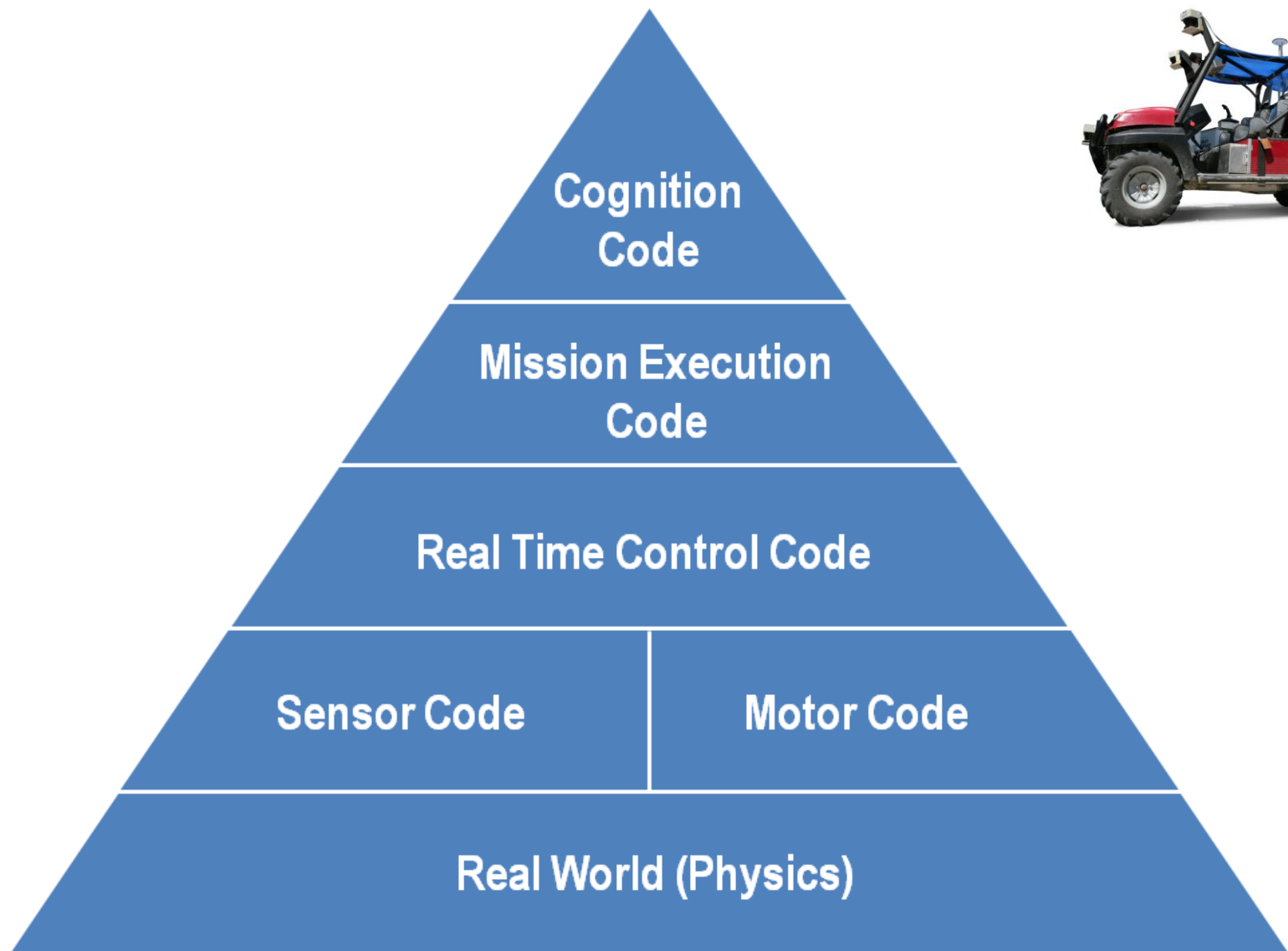


Dr. David Barrett

"The growing robotics industry badly needs an industrial-grade, hardened, richly supported software development system to build intelligent, autonomous, mobile robots that can sense, think, and act in the complex real world around them."

Robot-friendly development system needs:

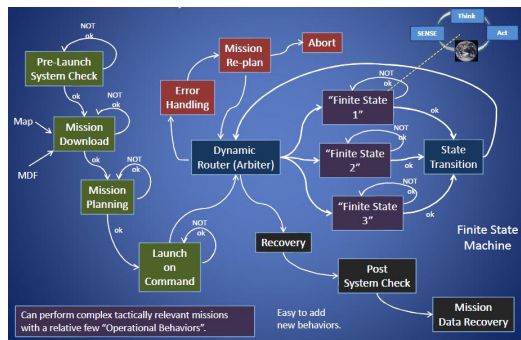




Top 3 Prototyping Challenges

1

Designing intelligent and reusable software



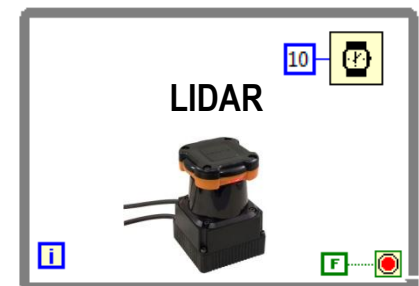
2

Translating algorithms to embedded hardware



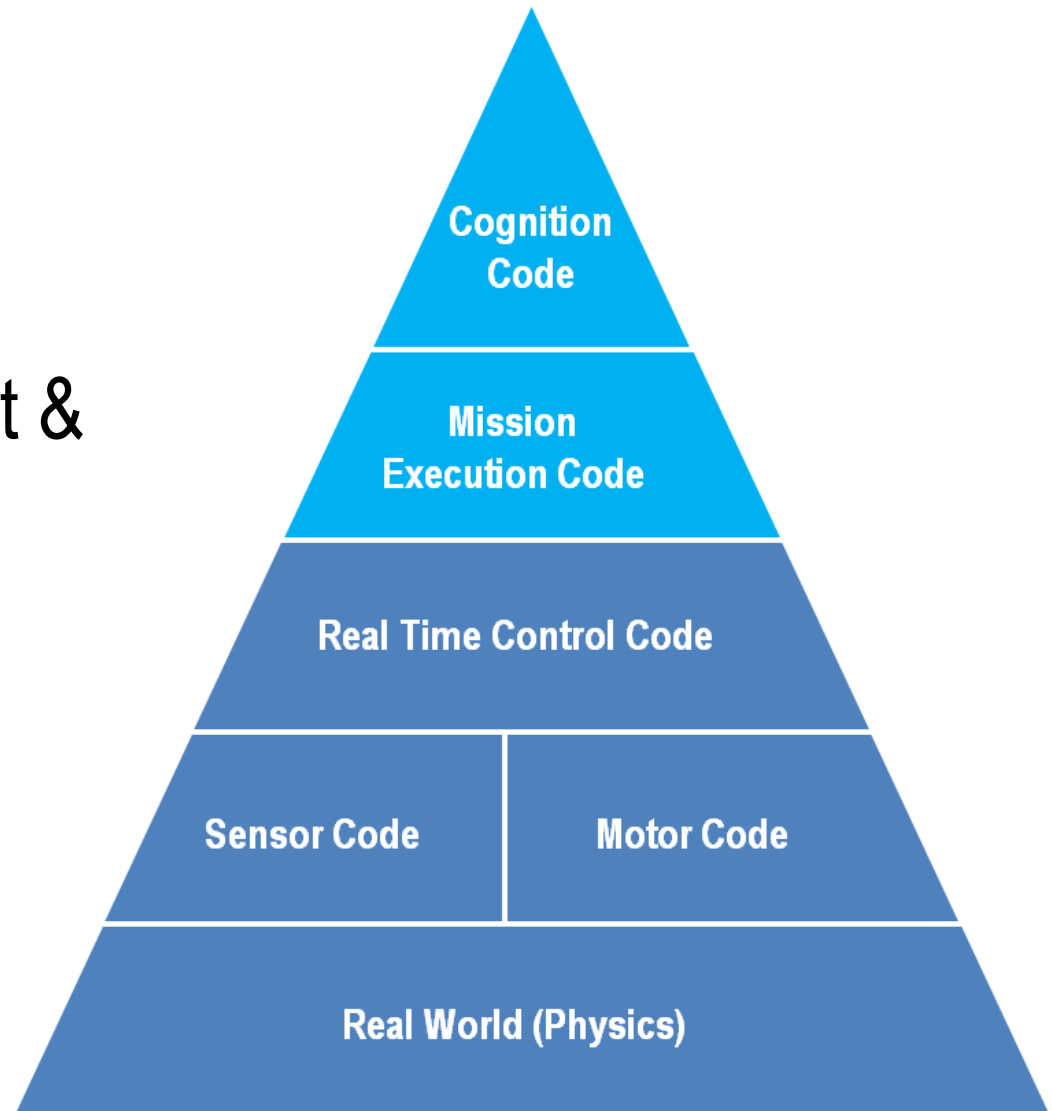
3

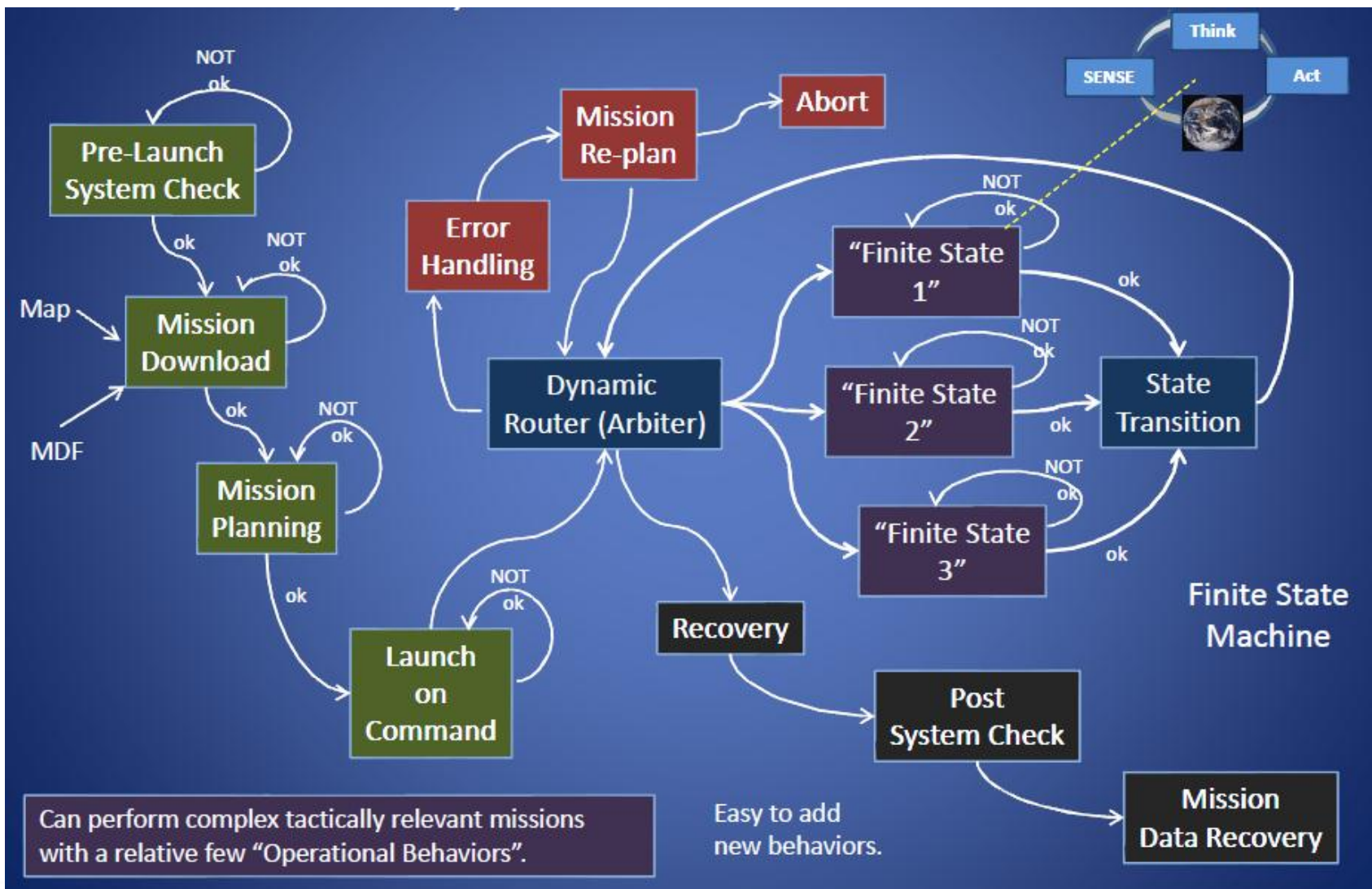
Connecting to the real-world



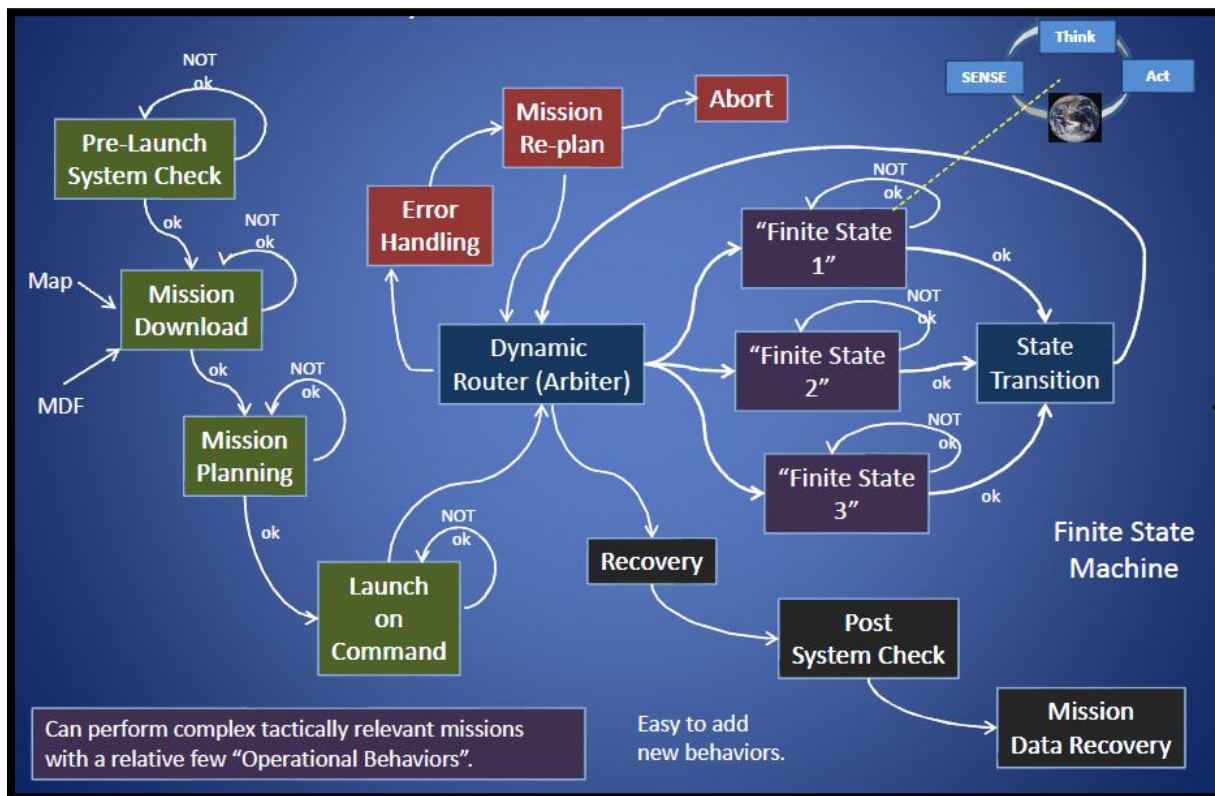
Prototyping Challenge #1:

Designing intelligent &
reusable software

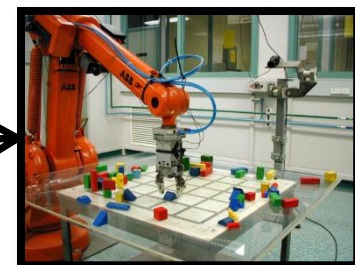
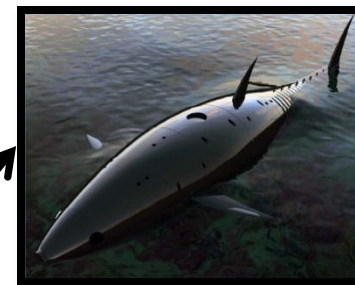




Robot application design pattern developed by students at Franklin W. Olin College



Robot application design pattern developed by students at Franklin W. Olin College



Mission Definition File (MDF)

Route Def-File

Action

Launch > WP1

Open water transit to GPS fix

WP1 > WP2

Open water transit to GPS fix

WP2 > WP3

Center channel transit to GPS fix

WP3 > WP4

Shore follow to GPS fix

WP4 > WP5

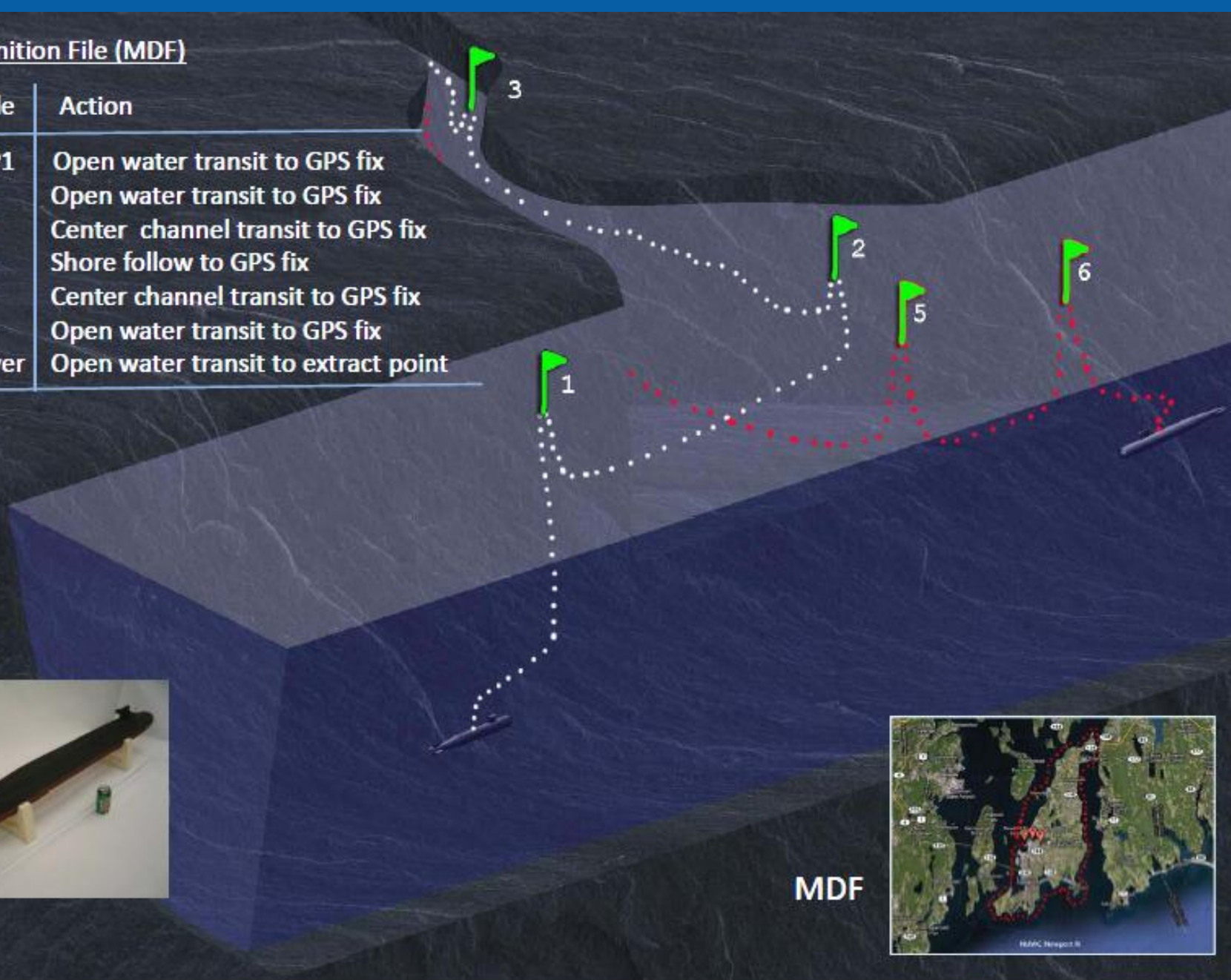
Center channel transit to GPS fix

WP5 > WP6

Open water transit to GPS fix

WP6 > Recover

Open water transit to extract point

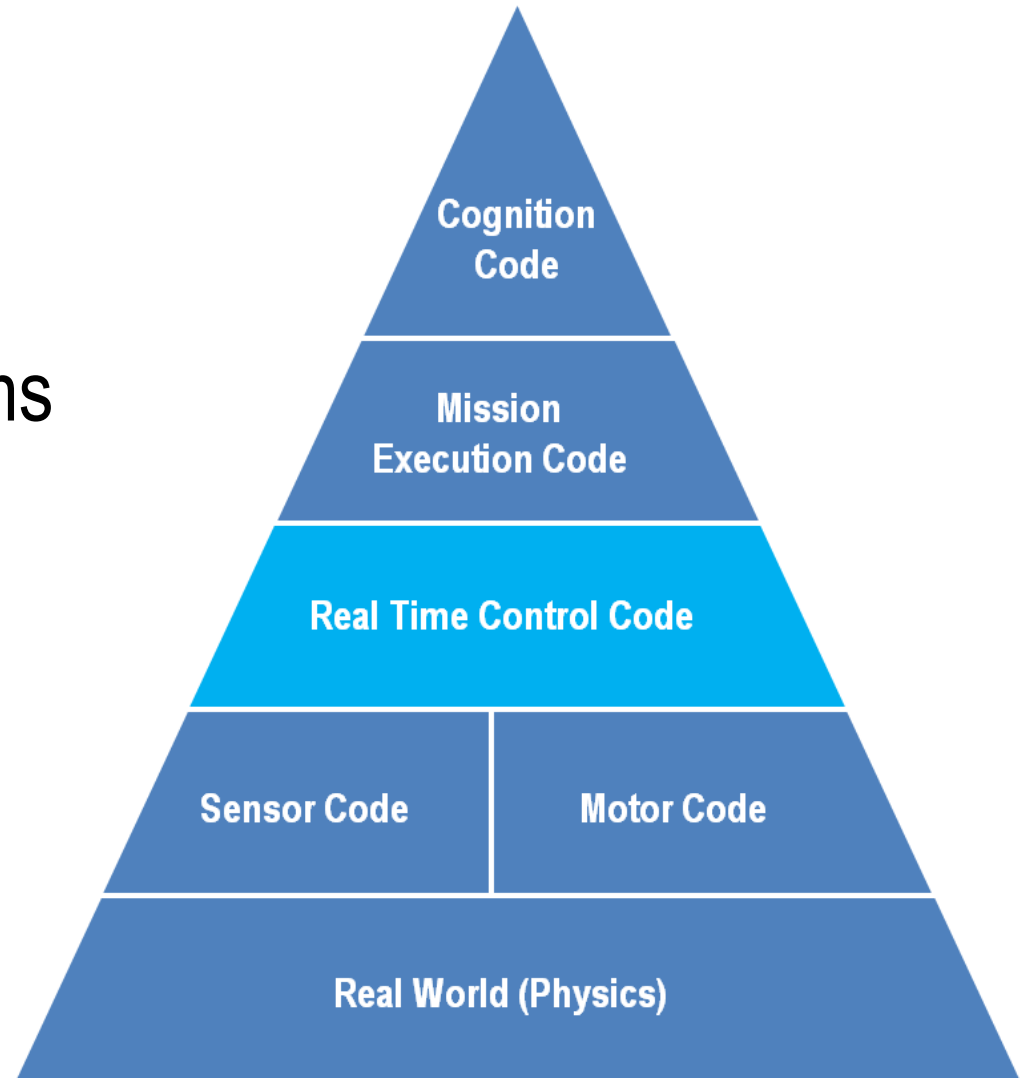


MDF

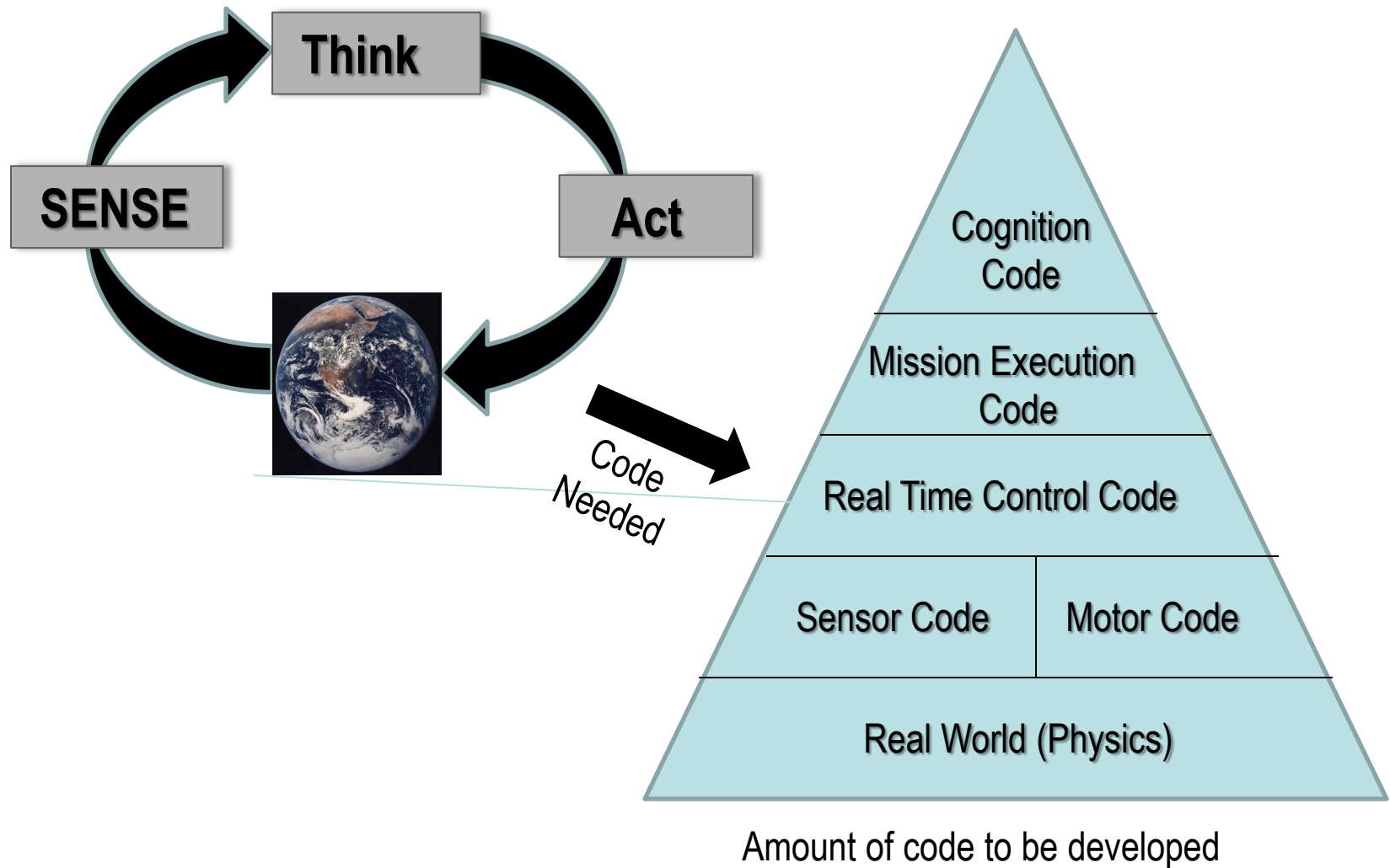


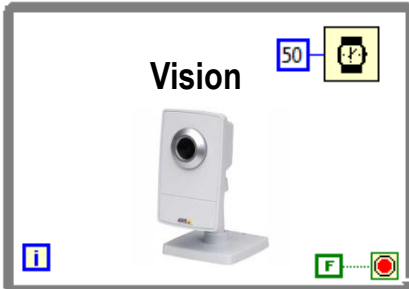
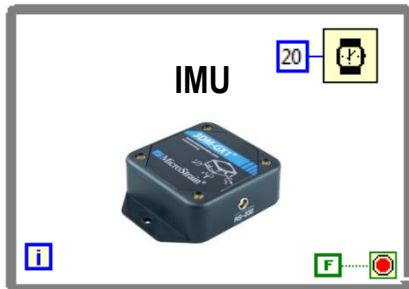
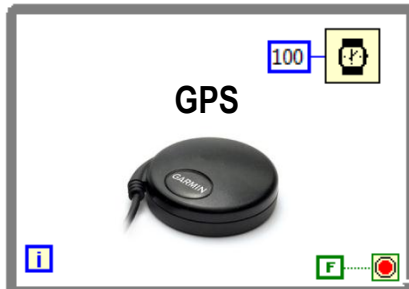
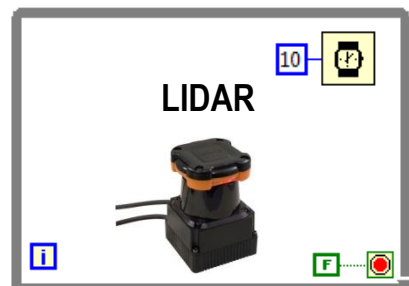
Prototyping Challenge #2:

Translating algorithms
to embedded
hardware



Sense-Think-Act flow needs lots of code:





True parallel loops

Sense

Act

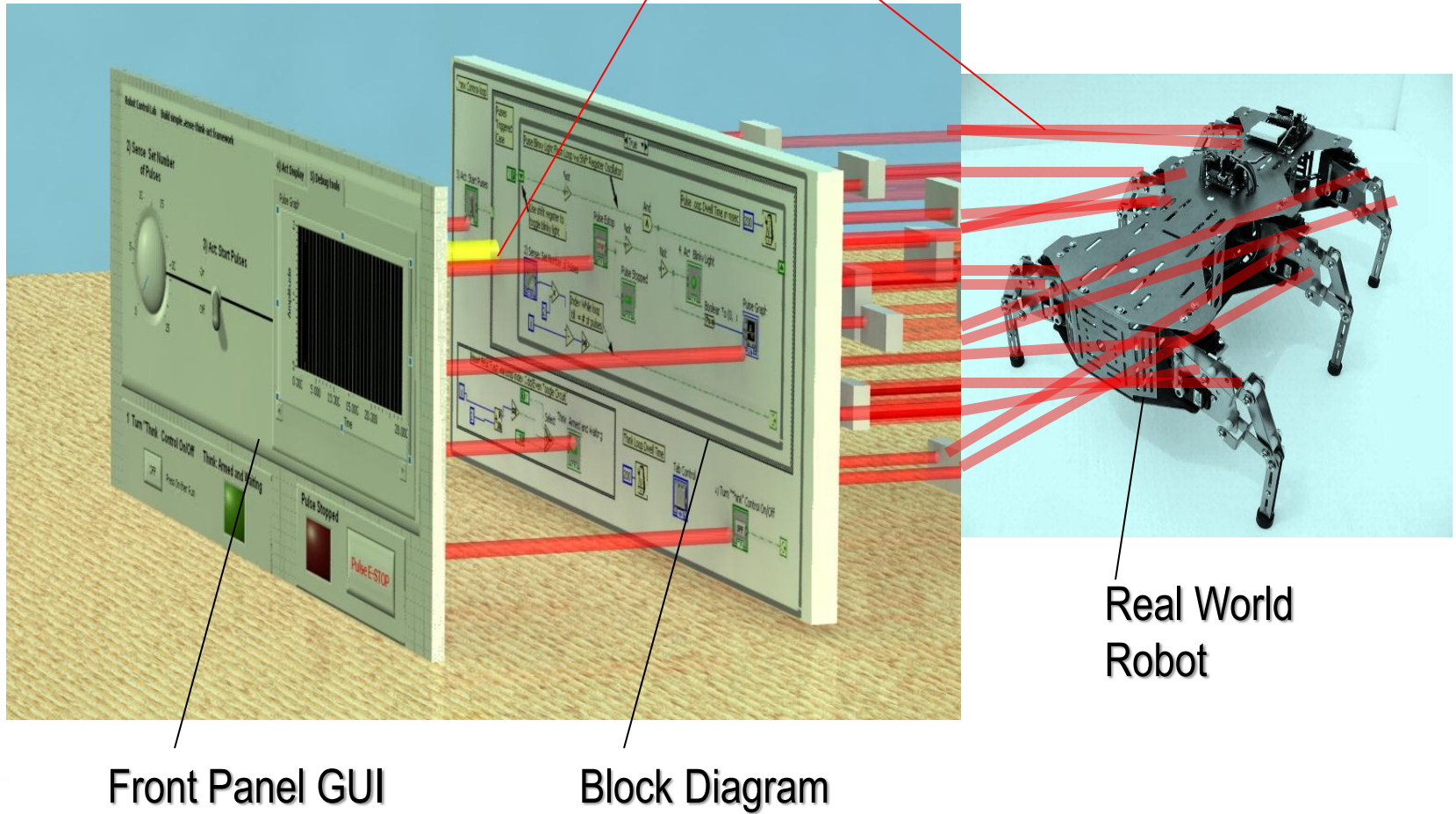
Think

Sensors and actuators can
run at their own native
speeds asynchronously



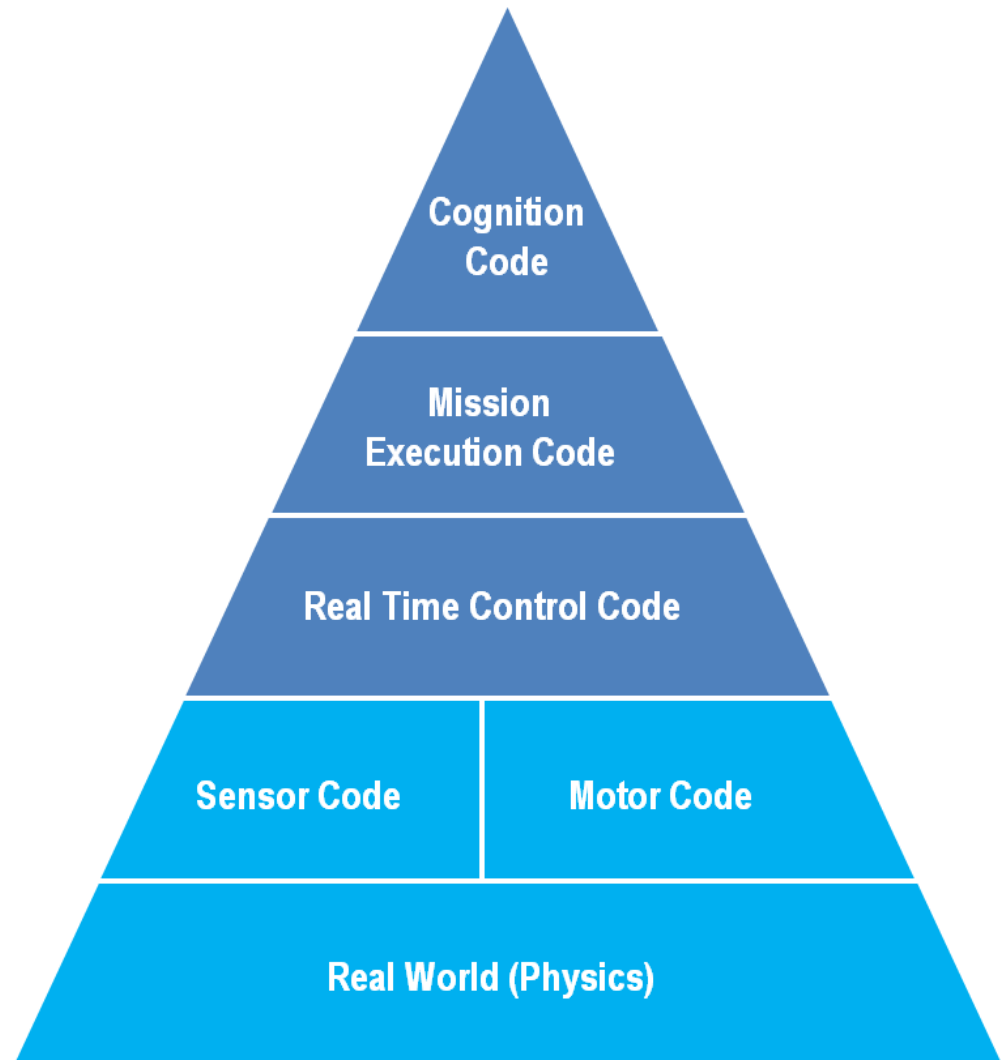
Non-abstract/Easy to Understand Control

Data Flow



Prototyping Challenge #3:

Connecting to the
real-world





NASA Langlely Research Robot

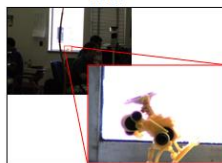
System Overview (Sensors)



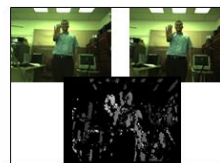
FLIR Photon
320^m Infrared
Imager



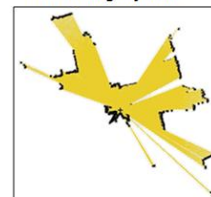
Fujinon C22x17R2D-
QP1TM TeleZoom CCTV
Lens



Videre Design Stereo
Cameras



SICK LD-OEM1000TM
Laser Ranger-finder



IMU Gyroscope
Microstrain 3DM-GX1



Directed Perception
PTU-D300 Pan-tilt



Raynox RA5237TM Omnidirectional
Camera Mirror



Laser Range Finder Hokuyo URG-
04LX



Differential GP
Trimble AG DGPS 132

SENSE: Perception:

Micron Sonar



BlueviewP900E-20
Imaging Sonar



Tritech SeaKing AUV
Side Scan Sonar System



Cruz-Pro D110
Digital DSP depth sounder



VexilarLPS-1
Digital Depth Sounder



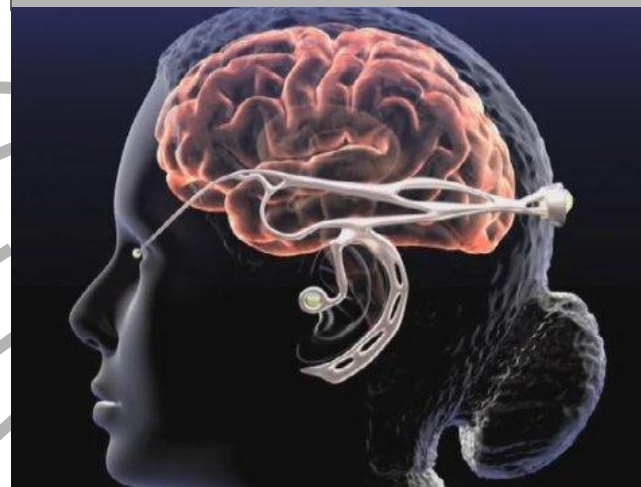
Point Gray Bumble Bee



NI 1722 Smart Camera



Perception Engine:
“What is around me?”



SENSE: Localization

TrackLink 10000 Integrated
USBL Acoustic Tracking
and Communication Systems



MARINS
Inertial Navigation System



OS3000 Digital Compass



FSA03 - FALCOM
GPS Smart antenna



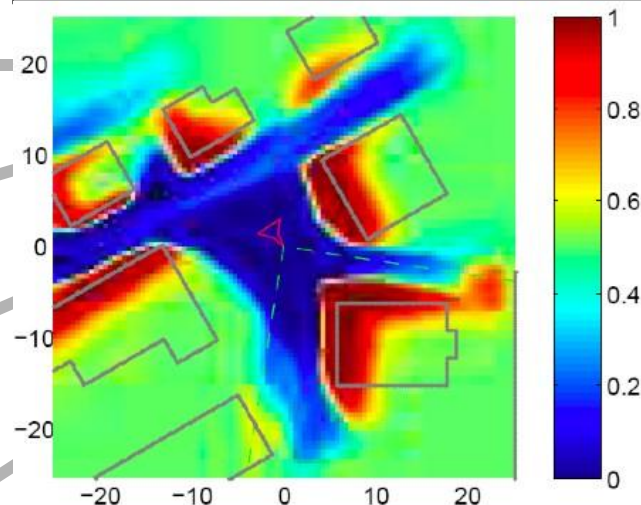
ASM POSITILT® Inclinometer



Depth Transducer
2400 Slimline Borehole



Localization Engine:
“Where am I?”



SENSE: Vehicle Status

Bilge Sensors YSBS-2



Internal Air
Temperature/
Pressure



**Vehicle Status Engine:
“How Am I?”**

Battery Voltage

Actuator Force(s)

Joint Position (s)

Thruster Speed(s)



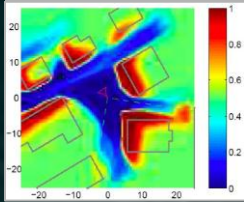
Think

Cognition Engine: Finite State Machine



Mission Definition File

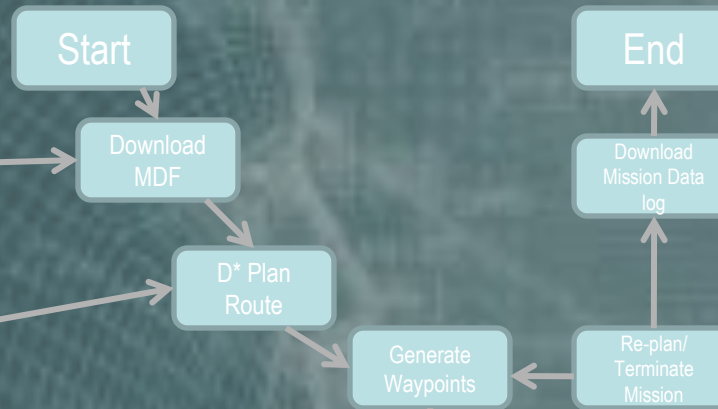
Localization Engine:
"Where am I?"



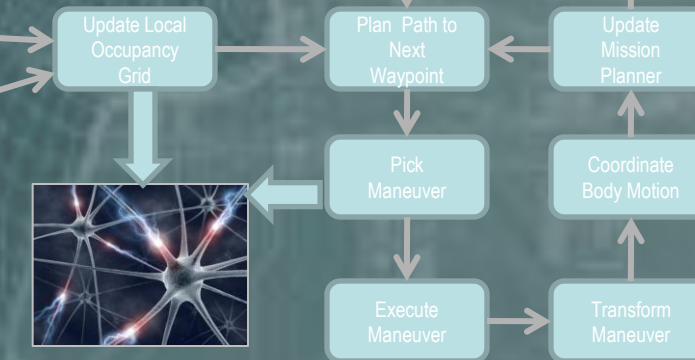
Perception Engine:
"What is around me?"



Strategic (Mission Planning and Execution)



Tactical (Behaviors)



Supervised Learning

Act

Act



Direct Drive



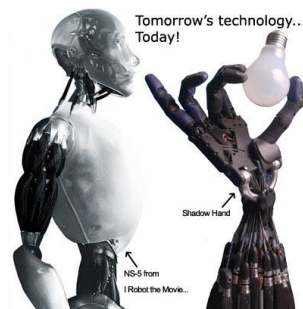
Lead Screw Drive



McKibben



Festo



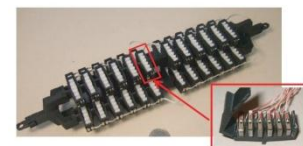
Shadow



Hughes



Micro Hydraulic

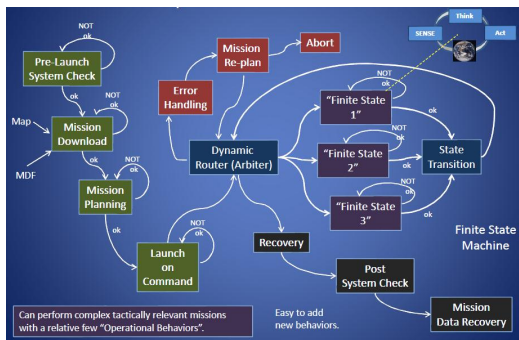


SMA, PZT, etc.

Top 3 Prototyping Challenges

1

Designing intelligent and reusable software



2

Translating algorithms to embedded hardware



3

Connecting to the real-world

